Approach for Assessment of On-Site Ecological Receptors at the Eagle Zinc Site

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As per the June 2, 2004 meeting, this technical memorandum describes the approach for the evaluation of on-Site ecological receptors in the Eagle Zinc SLERA. Revisions to the SLERA to incorporate the evaluation of on-Site receptors are expected in several sections, tables, and figures, not all of which are listed below. Comments on the SLERA provided earlier that relate to the evaluation of the on-Site ecological receptors should also be incorporated.

Selection of assessment and measurement endpoints (Section 4.5 and Table 4-5 of the SLERA)

- Assessment of on-Site terrestrial receptors. Terrestrial receptors may include, but are not limited to, soil invertebrates, deer mouse (omnivorous mammals), white-tailed deer (herbivorous mammals), American robin (omnivorous birds), and the red-tailed hawk (carnivorous birds).

- Assessment of on-Site aquatic receptors. Aquatic receptors may include, but are not limited to, benthic invertebrates, water-column invertebrates, fish, amphibians, raccoons (omnivorous mammals), great-blue heron, and mink.

- Measurement endpoints for lower trophic-level receptors (invertebrate communities, fish, and amphibians) will be the comparison maximum exposure case hazard quotients (HQs) to a target HQ of 1. Media-specific HQs are calculated for individual chemicals by dividing the maximum soil concentration by an invertebrate-based soil screening value.

- Measurement endpoints for upper trophic-level receptors will be the comparison of maximum exposure case HQs to a target HQ of 1. Food chain HQs are calculated for individual chemicals by dividing an estimated level of exposure by a screening ecotoxicity value that is associated with no adverse effects.

Screening-level Ecological Effects evaluation (Section 5.0)

For on-site aquatic receptors, the screening values should be the same as those used for off-site aquatic receptors.

For on-site terrestrial receptors, suitable screening values for direct exposure toxicity include the following:

Guidance Tools and Applications from Oak Ridge National Laboratory. http://www.esd.ornl.gov/programs/ecorisk/tools.html

USEPA 1995. Supplemental Guidance to RAGS: Region 4 Bulletins No. 2. Ecological Risk Assessment. Region IV, Waste Management Division. Office of Health Assessment. Values presented are as updated Aug. 1999. (http://www.epa.gov/region4/waste/ots/ecolbul.htm)

Screening ecotoxicity values for receptor species evaluated via food chain modeling were obtained from the literature. For each chemical (including those analyzed for but not detected) and each receptor, no observed adverse effect level (NOAEL) should be obtained. Suitable values can be found in the following reference:

Sample, B.E., D.M. Opresko, and G.W. Suter, II. 1996. Toxicological Benchmarks for Wildlife: 1996 Revision. Oak Ridge National Laboratory, Oak Ridge, TN. ES/ER/TM-86/R3.

Screening-level Exposure Estimates (Section 6.0)

Maximum detected concentrations in surface water, soil, and sediment will be used as the basis for estimating the chemical exposure to receptor communities and species. The maximum detection limit for contaminants that were analyzed for but not detected will also be compared to media-specific screening values and used for trophic modeling. This is done to ensure that detection limits are similar to chemical levels that are not expected to be associated with an impact to ecological receptors. For samples with duplicate analyses, the higher concentration will be used in the screening (i.e., when both values were detects or both values were non-detects). In cases where one result is a detection and the other a non-detect, the detected value was used in the assessment.

Volatile organic compounds will not be evaluated in the food chain models. Most of the volatiles have low octanol-water partitioning coefficients, and as such, are not expected to accumulate in tissue to any significant degree.

For receptor species used in food chain modeling, the dose of each chemical (in mg chemical per kg of body weight per day) will be calculated using species-specific life history information, where available. Minimum body weights and maximum ingestion rates for food, water, and soil/sediment will be used to develop exposure estimates. Average BAFs presented in Sample et al. (1998a,b) and Bechtel Jacobs Company, Inc. (1998a,b) will be used to estimate the concentration of chemicals in receptor prey items (i.e., small mammals, invertebrates, and plants). Maximum chemical concentrations in soil and sediment will be multiplied by BAFs for each prey type to determine the concentration of the chemical in the prey (on a dry weight basis). A BAF of 1 will be assumed when no literature value is available. Chemical contributions from the consumption of prey items will be estimated using the following equation:

$$SUF * C_{food} * FCR = Dose_{food}$$

where,
$Dose_{food}$ = chemical ingested per day via food (mg chemical/kg body weight [dry]-day);
FCR = food consumption rate (kg food [dry]/kg body weight [wet]-day);
C_{food} = maximum COPC concentration in food (mg chemical/kg food [dry]); and
SUF = site use factor (unitless).

In addition to the ingestion of chemicals accumulated in food items, receptors may also be exposed to chemicals through the ingestion of surface water. The following equation will be used to calculate the dose of each chemical that each receptor species would be expected to obtain from the ingestion of surface water:

$$SUF * C_{water} * WCR = Dose_{water}$$

where,
$Dose_{water}$ = chemical ingested per day via water (mg chemical/kg body weight [wet]-day);
WCR = surface water consumption rate (L of water/kg body weight [wet]-day);
C_{water} = maximum chemical concentration in surface water (mg chemical/L of water); and
SUF = site use factor (unitless).

Receptors may also be exposed to chemicals through the ingestion of soil and/or sediment while foraging. The following equation will be used to estimate the dose of each chemical that each receptor species would be expected to obtain from the ingestion of soil and/or sediment (expressed as sediment below):

$$SUF * C_{sediment/soil} * SCR = Dose_{sediment/soil}$$

where,
$Dose_{sediment/soil}$ = chemical ingested per day via sediment/soil (mg chemical/kg body weight [wet]- day);
SCR = sediment/soil consumption rate (kg sediment [dry]/kg body weight [wet]-day);
$C_{sediment/soil}$ = maximum chemical concentration in sediment/soil (mg chemical/kg [dry]); and
SUF = site use factor (unitless).

Soil and sediment ingestion rates are calculated by multiplying estimates of soil and sediment ingestion found in the literature (expressed as a percentage of total food intake) by the food consumption rate. In cases where a species-specific sediment ingestion value is not available in the literature, a value from a species with similar foraging habits will be used or a conservative value assumed.

Total chemical doses were calculated by summing doses via the ingestion of food, water, and soil and/or sediment with the following equation:

$$Dose_{sediment/soil} + Dose_{water} + Dose_{food} = Dose_{total}$$

where,

$Dose_{total}$ = the total amount of chemical ingested per day per kg body weight (mg chemical/ kg body weight [wet] - day).

In addition to the other assumptions already discussed, exposure estimates will be calculated assuming the site use factor is 1 (i.e., the receptor forages exclusively at the site), the bioavailability of ingested chemicals is 100 percent, and that 100 percent of the diet is contaminated.

Step 3

If the results of the SLERA suggest that further ecological risk evaluation or data collection is warranted, the ERA process should proceed to the baseline ERA which is a more detailed phase of the ERA process (Steps 3 through 7). The first step of the baseline ERA (Step 3) is the baseline problem formulation. The baseline problem formulation refines the risk estimates from the screening ERA using more realistic exposure assumptions (Step 3a), and if unacceptable risks are still possible, refines the conceptual model and endpoints (Step 3b) in order to determine the direction of subsequent steps of the ERA process.

The first activity (Step 3a) of the baseline ERA is to refine the conservative exposure assumptions employed in the screening ERA and recalculate the risk estimates. This reevaluation may include considerations of background, sample detection frequency, bioavailability, and realistic exposure scenarios. Realistic exposure scenarios might include the use of average rather than maximum: (1) exposure point concentrations, (2) species ingestion rates, and (3) exposure frequency or duration. A review of the literature will be used to refine the conservative exposure assumptions (such as species body weight) used in the screening ERA. In the screening ERA, minimum species body weights are used and these are often not region-specific. Average species body weights for the state, region, and/or subspecies will be used, if available.

Step 3a will also include a re-screening against medium-specific screening values. As appropriate to a baseline analysis, alternate screening values will be developed, where appropriate, to account for factors like bioavailability issues (such as the use of dissolved metals, rather than total metals, in surface water). These alternative screening values will be obtained from the scientific literature, available federal and state regulatory guidance, and other appropriate sources. These screening values will be adjusted, where appropriate, based on modifying factors such as hardness or total organic carbon. The rationale for these alternate screening values will be provided.

Following the completion of Steps 3a and (if warranted) 3b, a decision point will be reached with two potential outcomes. If Steps 3a and 3b indicate that there are no unacceptable risks, the ERA process would skip directly to Step 7 to document this conclusion. If unacceptable risks are still possible following Step 3, or if the level of uncertainty in the risk estimates is unacceptable, additional studies (Steps 4 through 6) should be undertaken to further refine the risk estimates. Completion of Step 7 ends the baseline (Tier 2) assessment.

References

Bechtel Jacobs Company LLC. 1998a. Biota Sediment Accumulation Factors for Invertebrates: Review and Recommendations for the Oak Ridge Reservation. Bechtel Jacobs Company LLC, Oak Ridge, TN. BJC/OR-112.

Bechtel Jacobs Company LLC. 1998b. Empirical Models for the Uptake of Inorganic Chemicals from Soil by Plants. Bechtel Jacobs Company LLC, Oak Ridge, TN. BJC/OR-133.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, and G.W. Suter, II. 1998a. Development and Validation of Bioaccumulation Models for Small Mammals. Oak Ridge National Laboratory, Oak Ridge TN. 89 pp. ES/ER/TM-219.

Sample, B.E., J.J. Beauchamp, R.A. Efroymson, G.W. Suter, II, and T.L. Ashwood. 1998b. Development and Validation of Bioaccumulation Models for Earthworms. Oak Ridge National Laboratory, Oak Ridge TN. 93 pp. ES/ER/TM-220.